

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

To:

BOULT WADE TENNANT
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Verulam Gardens
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UNITED KINGDOM

MR Pluckrose
Received 2 12/11/05
LU 14/11/05
in. Clary 2

(PCT Rule 44.1)

Date of mailing (day/month/year)	11/07/2005
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Applicant's or agent's file reference AWP/76638W000	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/GB2005/000117	International filing date (day/month/year) 14/01/2005
Applicant LOTUS CARS LIMITED	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.
3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:
- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
- ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Reminders

Shortly after the expiration of 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.


The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise, the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the PCT Applicant's Guide, Volume II, National Chapters and the WIPO Internet site.

RECEIVED

Name and mailing address of the International Searching Authority  European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer 11 JUL 2005 Augustinus Middeldorp BOULT WADE TENNANT
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference AWP/76638W000	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/GB2005/000117	International filing date (day/month/year) 14/01/2005	(Earliest) Priority Date (day/month/year) 14/01/2004
Applicant LOTUS CARS LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ The international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box II).

3. ☐ **Unity of invention is lacking** (see Box III).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1, 2

☐ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☒ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB2005/000117

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

The present invention relates to an internal combustion engine comprising: a combustion chamber (10); first (A) and second (B) inlet valves controlling flow of air into the combustion chamber; first (C) and second (D) exhaust valves; and first (16) and second (18) turbochargers. The first turbocharger (16) is connected to the first inlet valve (A) and the second turbocharger (18) is connected to the second inlet valve (B). The first turbocharger (16) is connected to the first exhaust valve (C) and receives only combusted gases expelled via the first exhaust valve (C). The second turbocharger (18) is connected to the second exhaust valve (D) and all combusted gases expelled via the second exhaust valve flow to the second turbocharger (18) without passing through the first turbo-charger (16). The first inlet valve (A) and first exhaust valve (C) are controlled independently from the second inlet valve (B) and the second exhaust valve (D).

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB2005/000117

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F02B37/007 F02B37/02 F02B37/013 F02D13/02 F02B29/04
F01L9/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F02B F02D F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 959 961 A (HIERETH ET AL) 2 October 1990 (1990-10-02) column 2, lines 2-7, 19-21, 28-34 column 3, lines 18-24, 45-56, 67, 68 column 4, lines 1, 2, 8-10; figure 1 -----	1-14
X	PATENT ABSTRACTS OF JAPAN vol. 011, no. 048 (M-561), 13 February 1987 (1987-02-13) & JP 61 210224 A (MAZDA MOTOR CORP), 18 September 1986 (1986-09-18) abstract -----	1, 5



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

24 June 2005

Date of mailing of the international search report

11/07/2005

Name and mailing address of the ISA

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NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Boye, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB2005/000117

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 4959961	A	02-10-1990	DE	3815991 C1	20-07-1989
			JP	1318720 A	25-12-1989
JP 61210224	A	18-09-1986	JP	1832341 C	29-03-1994

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/GB2005/000117

International filing date (day/month/year)
14.01.2005

Priority date (day/month/year)
14.01.2004

International Patent Classification (IPC) or both national classification and IPC
F02B37/007, F02B37/02, F02B37/013, F02D13/02, F02B29/04, F01L9/02

Applicant
LOTUS CARS LIMITED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



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Authorized Officer

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

10/585588

International application No.
PCT/GB2005/000117

AP20 Rec'd PCT/PTO 11 JUL 2006

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43bis.1 and 64.1) is the claimed priority date.
2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43bis.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.
3. Additional observations, if necessary:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/GB2005/000117

Box No. V Reasoned statement under Rule 43b/s.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	4,10,13
	No: Claims	1-3,5-9,11,12,14
Inventive step (IS)	Yes: Claims	
	No: Claims	4,10,13
Industrial applicability (IA)	Yes: Claims	1-14
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

AP20 Rec'd PCT/PTO 11 JUL 2006

Re Item V.

1 Reference is made to the following documents:

D1 : US 4 959 961 A (HIERETH ET AL) 2 October 1990 (1990-10-02)

D2 : PATENT ABSTRACTS OF JAPAN vol. 011, no. 048 (M-561), 13 February 1987
(1987-02-13) & JP 61 210224 A (MAZDA MOTOR CORP), 18 September 1986
(1986-09-18)

2 INDEPENDENT CLAIM 1

2.1 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claim 1 is not new in the sense of Article 33(2) PCT.

Document D1 discloses (the references in parentheses applying to this document):

an internal combustion engine comprising a combustion chamber, first and second inlet valves controlling flow of air into the combustion chamber, first and second exhaust valves controlling flow of combusted gases out of the combustion chamber, first and second turbochargers, the first turbocharger being connected to the first inlet valve and the second turbocharger being connected to the second inlet valve where charge air supplied to the combustion chamber via the first inlet valve is pressurised only by first turbocharger and charge air supplied to the combustion chamber via the second inlet valve is pressurised only by the second turbocharger, where the first turbocharger is connected to the first exhaust valve and receives only combusted gases expelled via the first exhaust valve and the second turbocharger is connected to the second exhaust valve and all combustion gases expelled via the second exhaust valve flow to the second turbocharger without passing through the first turbocharger and where a valve operation means controls operation of the first inlet valve and the first exhaust valve independently from the operation of the second inlet valve and second exhaust valve thereby providing variation in the ratio of the mass of charge air supplied to the combustion chamber via the first inlet valve to the mass of charge air supplied to the combustion chamber via the second inlet valve.

2.2 Document D2 is also anticipating the novelty of claim 1 of the application.

3 DEPENDENT CLAIMS 2-14

Dependent **claims 2-14** do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (Article 33(2) and (3) PCT).

- D1 discloses a deactivation of the second inlet and exhaust valves (**claims 2,6**)
- D1 discloses a simultaneous activation of the first and second inlet and exhaust valves (**claim 3**)
- A series connection of a low and a high pressure turbocharger is well known in the art and a skilled person would combine this knowledge with the disclosure of D1 to come to a combination as claimed in **claims 4,10**
- D1 discloses separate exhaust paths per turbocharger (**claim 5**)
- D1 discloses a first inlet channel port imparting swirl and a second inlet channel port imparting less swirl (**claims 7,8**)
- D1 discloses two intercoolers in the respective charge air flows (**claim 9**)
- D1 discloses an increase of air flow to the second inlet during periods of acceleration at higher load (**claims 11,12**)
- Fully variable hydraulic valvetrains are state of the art and a skilled person would combine them with the teaching of D1 to come to a turbocharged internal combustion engine as claimed in **claim 13**.

- 3.1 A combination of the subject matter of claims 2,13 and a clarified claim 6 (see VIII, 5.) could probably lead to a novel and inventive turbocharged internal combustion engine.

Re Item VII.

4. Claim 14 contains a reference to the drawings. According to Rule 6.2(a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here.
- 4.1 Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combi-

nation from the prior art (document D1) being placed in the preamble (Rule 6.3(b)(I) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

4.2 The closest prior art D1 should be mentioned in the description (Rule 5.1(a)(ii) PCT).

Re Item VIII.

- 5 Claim 6 is unclear (Article 6 PCT) insofar as when the second inlet valve and the second exhaust valve are closed, **NO** charge air can be pressurised by the second turbocharger. Claim 6 should probably refer to the first inlet and exhaust valve.

[54] **SUPERCHARGED INTERNAL COMBUSTION ENGINE**

[75] Inventor: Hermann Hiereth, Esslingen, Fed. Rep. of Germany

[73] Assignee: Daimler-Benz Aktiengesellschaft, Stuttgart, Fed. Rep. of Germany

[21] Appl. No.: 347,055

[22] Filed: May 4, 1989

[30] **Foreign Application Priority Data**

May 10, 1988 [DE] Fed. Rep. of Germany 3815991

[51] Int. Cl.³ F02B 37/00

[52] U.S. Cl. 60/612; 123/432

[58] Field of Search 60/609, 612; 123/432

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,380,777 7/1945 Moss 60/612 X
4,538,574 9/1985 Lombardi 60/612 X

FOREIGN PATENT DOCUMENTS

32976 3/1980 Japan 123/432

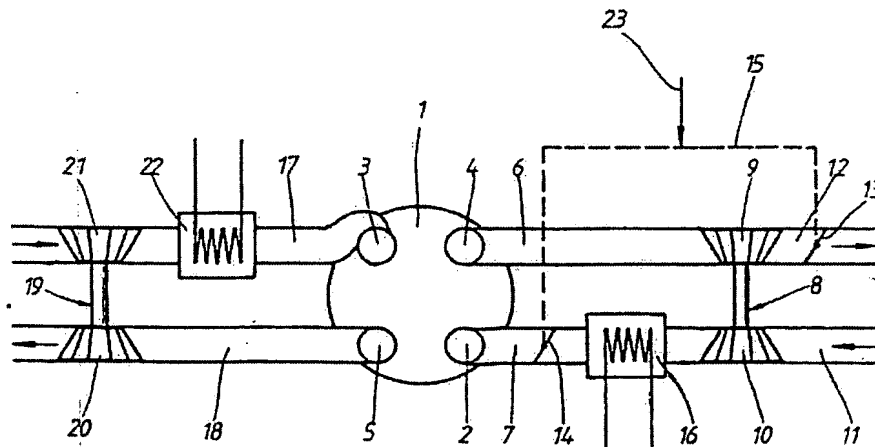
1247573 7/1986 U.S.S.R. 60/609
2005765 4/1979 United Kingdom 60/612

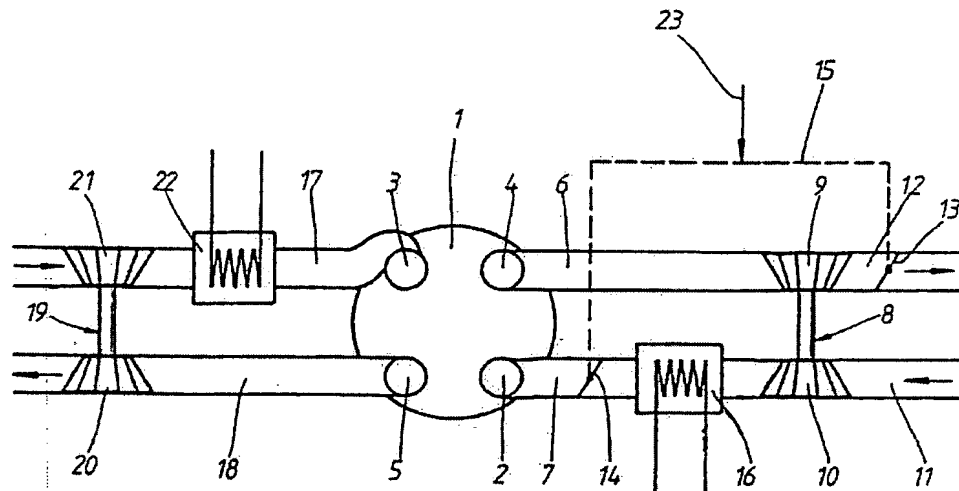
Primary Examiner—Michael Koczo
Attorney, Agent, or Firm—Evenson, Wands, Edwards,
Lenahan & McKeown

[57] **ABSTRACT**

The invention concerns a supercharged internal combustion engine in which two inlet ducts, which can be closed by inlet valves and whose flows are separated from one another, and two exhaust ducts which can be closed by exhaust valves enter the combustion space of a cylinder, one inlet duct and one exhaust duct being associated with one exhaust gas turbocharger. In order to achieve both a rapid build-up of supercharge pressure in the case of positive load changes and also an optimum homogenization of the mixture in the combustion space, the two exhaust ducts are also arranged so that their flows are separated and the inlet and exhaust side connected to the same exhaust gas turbocharger can be closed by one shut-off element each.

8 Claims, 1 Drawing Sheet





SUPERCHARGED INTERNAL COMBUSTION ENGINE

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention generally concerns a supercharged internal combustion engine and more particularly to a supercharged internal combustion engine having a pair of turbochargers each connected between separate inlet and outlet ducts which can be selectively closed to improve the performance of the engine.

An internal combustion engine capable of supercharging disclosed in JP-A 61-210224 provides for the admission to the two exhaust gas turbochargers to be always equal over the whole load and rotational speed range. In consequence, only relatively low exhaust gas flow velocities are available in the lower rotational speed ranges. The supercharge rotational speeds are therefore so low that there is only a very sluggish build-up of supercharge pressure in the case of a positive change of load. The flow velocities in these operating ranges are also low on the inlet side of the supercharger so that, because of the reduced turbulence in the combustion space of the internal combustion engine, satisfactory mixture formation is not ensured, particularly in the case of diesel engines.

An internal combustion engine which is supercharged by two exhaust gas turbochargers, of which one can be put out of operation, if required, by means of shut-off elements in the exhaust and inlet regions, is disclosed from German Patent (DE-PS) 850 965. The flows in the inlet and exhaust ducts of the two turbochargers are connected together so that the two supercharged devices act like a single turbocharger when a second turbocharger is added. However, German Patent (DE-PS) 850 965 gives no information on how the individual inlet and exhaust ducts are to be arranged in the case where a four-valve cylinder head is used.

In JP-A 60-79123, it is disclosed to arrange the valves on a four-valve cylinder head in such a way that with respect to a hypothetical square, whose corners are formed by the two inlet and exhaust valves, the two inlet valves lie on one diagonal and the two exhaust valves lie on the other diagonal.

An object of the present invention is to produce a supercharged internal combustion engine having a pair of exhaust gas turbochargers each connected between separate inlet and outlet ducts which are selectively closed to provide a clearly improved build-up of supercharge pressure in the case of a positive change in load.

It is a further object of the present invention to provide a supercharged internal combustion engine wherein optimum mixture formation in the combustion space can be achieved even in the lower rotational speed ranges.

The invention achieves these and other objects by providing a shut off element at each of an inlet side and an exhaust side connected to the same turbocharger which can be selectively closed to improve engine performance.

Because, in the internal combustion engine according to certain preferred embodiments of the present invention, one of the two exhaust gas turbochargers can be separated from both the turbine side and the compressor side by suitable shut-off elements, it is possible for the whole of the exhaust gas of a cylinder to be pumped to the turbine via one exhaust duct only. In consequence,

the exhaust gas achieves a relatively high flow velocity. The supercharger rotational speed can therefore be held at a relatively high level even in the lowest rotational speed ranges when one exhaust gas turbocharger is separated from the system so that a rapid build-up of supercharge pressure is ensured in the case of a positive change in load.

In accordance with further preferred embodiments of the present invention, as on the exhaust side, the whole of the induced gases flow into the combustion space via only one inlet duct instead of two when one exhaust gas turbocharger is separated from the system. This, of course, again leads to a higher flow velocity so that optimum conditions for intensive mixing of the fuel with the combustion air are present even in the lower rotational speed ranges.

The mixture formation is improved still further according to further preferred embodiments of the invention if the inlet duct on the non-closable inlet side is, in addition, designed as a swirl duct. By this means, optimum adaptation of the swirl level necessary in the cylinder is provided for good mixture formation over various load and rotational speed conditions of the internal combustion engine by appropriately switching on or off one exhaust gas turbocharger. If the non-closable inlet duct is designed with, for example, high swirl, the swirl in the cylinder can be held substantially constant over the whole rotational speed range of the internal combustion engine by the addition, if appropriate, of a weak-swirl second inlet duct. On the other hand, however, high turbulence levels can be generated in high rotational speed ranges in the case of spark-ignition engines, for example.

The diagonal arrangement of the valves in accordance with the teachings of the present invention is advantageous in that it ensures an optimum heat distribution in the cylinder head, in contrast to the arrangement with inlet and exhaust valves parallel to the engine axis, in which the temperature drop between the hot exhaust side and the cold (relative to the exhaust side) inlet side is very large.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

The single Figure shows an embodiment of an internal combustion engine according to the teachings of the present invention in a diagrammatic representation.

DETAILED DESCRIPTION OF THE DRAWING

A combustion space of an internal combustion engine, in which the gas exchange is controlled by two inlet valves 2 and 3 located diagonally opposite to one another and two exhaust valves 4 and 5 also arranged diagonally opposite to one another, is indicated in plan view by 1. The exhaust valve 4 is located in a first exhaust duct 6 and the inlet valve 2 in a first inlet duct 7.

Also provided is a first exhaust gas turbocharger 8 whose turbine 9 can be subjected to exhaust gas via the first exhaust duct 6 and whose compressor 10 pumps the fresh air induced via the induction pipe 11 through the inlet duct 7 into the combustion space 1.

Butterfly valves 13 and 14 are respectively located in an exhaust gas pipe 12 connected to the turbine 9 and in

the inlet duct 7; these butterfly valves 13 and 14 can each be held in only the closed or open position. The two butterfly valves 13 and 14 are connected with one another by the actuation linkage 15, shown by the dotted lines in the drawing, in such a way that completely synchronous actuation of the two butterfly valves 13 and 14 can be achieved. A supercharge air cooler 16 is provided between the butterfly valve 14 and the compressor 10.

The inlet valve 3 is located in a further inlet duct 17, which is preferably designed as a swirl duct in the region of the inlet into the combustion space 1, and the exhaust valve 5 is located in a further exhaust duct 18. An exhaust gas turbocharger 19 is also provided on this valve side; the turbine 20 of this supercharger can be subjected to exhaust gas and its compressor 21 pumps the fresh air in the direction of the combustion space 1. Heat is again extracted from the supercharged air by a cooler 22.

During the operation of the internal combustion engine, both butterfly valves 13 and 14 are held in the closed position in the lower speed range, i.e. up to a specified engine rotational speed limiting value n_G , so that the exhaust gas turbocharger 8 is inoperative and the gas exchange in combustion space 1 takes place exclusively by the two valves 3 and 5. The fresh air pumped by the compressor 21 then flows through the swirl-type inlet duct 17 with increased swirl into the combustion space 1 of the internal combustion engine. Because of the fact that all the fresh gases are fed into the combustion space 1 via the inlet duct 17 only, there is a high flow velocity in this duct 17 and this has a positive effect on the swirl and turbulence generation in the combustion space 1.

In a manner analogous to the inlet side, the exhaust gases flow with a relatively high flow velocity, because the exhaust duct 6 is closed, through the exhaust duct 18 to the turbine 20. This high exhaust gas flow velocity therefore ensures a high rotational speed level of the exhaust gas turbocharger 19 even in the lower engine rotational speed range so that this turbocharger responds very rapidly, for example after a positive change in load.

In the medium and high rotational speed ranges, i.e. after attainment of the specified engine rotational speed limiting value n_G , the two butterfly valves 13 and 14 are switched to the open position with appropriate actuation of the linkage 15 by a suitable servodrive or the like (symbolically represented by the arrow 23). The two valves 2 and 4 then resume participation in the gas exchange control, i.e. the exhaust gases now flow via both turbines 9 and 20 and the fresh gases are pumped via both compressors 10 and 21 in to the combustion space 1. The fresh gas flow entering the combustion space 1 via the inlet duct 7, which is designed to have practically no swirl, then acts to support the swirl motion of the fresh gases flowing in via the inlet duct 17.

Actuation of the two butterfly valves 13 and 14 as a function of rotational speed can, of course, be replaced by actuation as a function of other operating parameters of the internal combustion engine, such as the internal combustion engine load.

The position of the two butterfly valves 13 and 14 is not limited to that shown in the single Figure. The butterfly valves 13 and 14 can be located at any given position on the outlet and inlet sides i.e. also, for example, upstream of the turbine 9 and upstream of the compressor 10. In addition, it is also conceivable to separate one exhaust gas turbocharger from the system by put-

ting the two valves 2 and 4 themselves out of operation directly instead of by means of two butterfly valves.

The invention is not, of course, limited to single-cylinder internal combustion engines only. In the case of a multiplicity of cylinders, several exhaust ducts and several inlet ducts of one turbocharger side can, of course, be respectively combined into one collecting main. It is only necessary to ensure that the flows of the inlet and exhaust ducts of one turbocharger side are always separated from those of the other turbocharger side.

In order to utilize momentum, it is also conceivable in the case of 6, 8 or 12 cylinder internal combustion engines - to use two exhaust gas turbochargers with twin-flow casings.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.

What is claimed:

1. Supercharged internal combustion engine in which two inlet ducts, each of which can be closed by an inlet valve, and two exhaust ducts, each of which can be closed by an exhaust valve, enter a combustion space and in which one inlet duct and one exhaust duct are connected to a compressor and turbine, respectively, of a first exhaust gas turbocharger and the other inlet duct and exhaust duct are connected to a compressor and turbine, respectively, of a second exhaust gas turbocharger, the two inlet ducts being arranged so that flows therethrough are separate from one another and the two exhaust ducts being arranged so that flows therethrough are separate from one another, wherein one of the first and second exhaust gas turbochargers has an inlet and an outlet, and a shut-off element operatively associated with the inlet and outlet selectively shuts off the inlet and outlet.

2. Supercharged internal combustion engine according to claim 1, wherein the shut-off element closing the exhaust is a butterfly valve located in an exhaust gas pipe provided downstream of the turbine, and the shut-off element closing the inlet is a butterfly valve located in an inlet duct.

3. Supercharged internal combustion engine according to claim 1, wherein means is provided for closing each shut-off element below a predetermined value of an internal combustion engine rotational speed.

4. Supercharged internal combustion engine according to claim 2, wherein means is provided for holding both butterfly valves in the closed position below a specified limiting value n_G of an internal combustion engine rotational speed.

5. Supercharged internal combustion engine according to claim 2, wherein the two butterfly valves are coupled together by a device which produces their synchronous displacement.

6. Supercharged internal combustion engine according to claim 1, wherein with respect to a hypothetical square having corners formed by the two inlet valves and the two exhaust valves, the two inlet valves lie on one diagonal of the square and the two exhaust valves lie on another diagonal of the square.

7. Supercharged internal combustion engine according to claim 1, wherein the inlet duct of the inlet side which does not have a shut-off element is designed as a swirl duct.

8. Supercharged internal combustion engine according to claim 1, wherein the two inlet ducts have different swirl levels.

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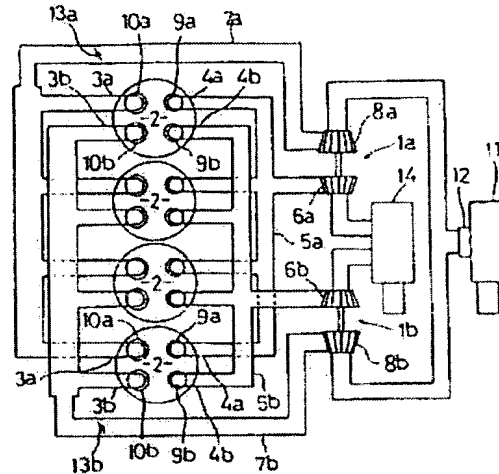
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TURBOSUPERCHARGER



ABSTRACT : PURPOSE: To improve engine output by connecting independently to two turbochargers, suction and exhaust ports at one side and those at the other side of a plurality of suction and exhaust ports on each cylinder, and by making different each opening and closing timing for a plurality of suction and exhaust valves.

CONSTITUTION: In a multi-cylinder engine where two exhaust turbochargers 1a and 1b are provided in parallel, each cylinder 2 is provided with primary and secondary suction ports 3a and 3b, and corresponding exhaust ports 4a and 4b. An exhaust from each exhaust port 4a and 4b is independently led to the turbines 6a and 6b of the turbochargers 1a and 1b through separated exhaust passages 5a and 5b, and turbocharged air from the compressors 8a and 8b of the turbochargers 1a and 1b are independently introduced to each suction port 3a and 3b through separated suction passages 7a and 7b. Also, a suction valve 10a and an exhaust valve 9b are choked and released at earlier timing than another suction and exhaust valves 10b and 9a.

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